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(71) Applicant

N V Philips' Gloeilampenfabrieken (Netherlands),
Groenewoudseweg 1, 5621 BA Eindhoven, The
Netherlands

(72) Inventor

Ernest Goldstern

(74) Agent and/or Address for Service

R J Boxall,
Mullard House, Torrington Place, London WC1E 7HD

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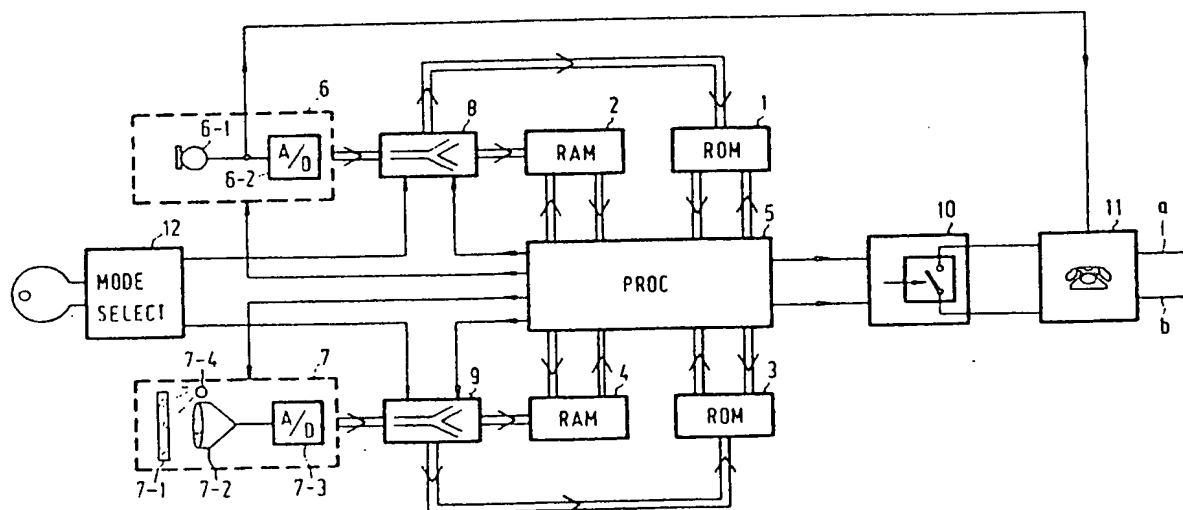
G4R

H4K

(54) Method of determining authorization of the user of a subscriber set

(57) The authorization of the user of a portable personal automatic telephone is partly determined by comparing the voice characteristic of the user with that of the authorized person and is further determined by comparing the fingerprint pattern of the user with the fingerprint pattern of the authorized person.

The arrangement includes a processor (5) which compares stored characteristics (ROM 1, 3) with user entered characteristics (RAM 2, 4). The switch (10) can be operated in response to correlations between one or both of the characteristics depending on the use to which the set is to be put.



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SPECIFICATION

Determining the user authorization of a subscriber set for signal transmission

5 The invention relates a method of determining whether a user is authorized to use a subscriber set for signal transmission and to a subscriber set for signal transmission including user authorization determining means.

10 Such a method and such a subscriber set are disclosed in European Patent Specification No. EP-B1-0 027 596.

15 Generally, it is useful to provide a subscriber set for signal transmission, such as, for example, a telephone set with a protection against unauthorized use, as the use of the subscriber set is always charged to the subscriber. With the present-day development of
20 mobile subscriber sets (for example the so-called automatic personal telephone, as described in the article "The cellular telephone goes on line", published in the periodical "Electronics" of 22nd September 1983,
25 pages 121-129), special account must be taken of the risk of non-authorized use. These portable sets may be found abandoned more frequently than wired sets, for example in the event of loss or theft.

30 It is already known to protect the subscriber set from unauthorized use by providing it with a lock to prevent unauthorized use. The authorized user identifies himself by using the appropriate key. The subscriber set may alternatively be arranged such that it is capable of
35 recognizing a code on an identification card of the authorized person. These known manners of protection have the disadvantage that a physical identification device (key or card) is
40 always necessary which may get lost.

45 From the above-mentioned European Patent Specification it is known to determine the user authorization of a telephone set by comparing the voice characteristic of the user with the voice characteristic of the authorized person. The human voice is an individual, unambiguous characteristic. With this personal characteristic it is possible to try to identify the owner of the voice unambiguously, so that in
50 this way of determining the user authorization no physical identification device is required.

55 Several methods of identifying a person by means of his voice pattern are known. In all these methods the error probability, (i.e. the probability that a speaker is erroneously identified as non-authorized or a non-authorized speaker is erroneously identified as authorized) depends on the available computer and memory capacities and on the available computing time. If a great deal of memory capacity is available the speech samples can be stored in a more extensive form, which requires more computing time, such as described in, for example, the article "Talking
65 with computers: Synthesis and Recognition of

Speech by Machines"; IEEE Transactions on Biomedical Engineering, Vol. BME-29, No. 4, April 1982, Pages 223-232, more specifically page 230, paragraph III-F.

70 When determining the user authorization of a subscriber set for signal transmission it is undesirable for time necessary to arrive at a decision whether the set will be enabled or not, to be longer than a few seconds, as this
75 would be annoying for the user. With a prescribed processing rate of the data such a fast decision can be realized by limiting the number and size of the recorded speech samples, but this increases the error probability. More
80 extensive recording of the speech samples implies a larger storage capacity and higher processing rates which, for reasons of cost and volume, is undesirable, especially with portable subscriber's sets such as used in said
85 system of automatic personal telephones.

90 It is an object of the invention to provide a method of determining whether a user is authorized to use a subscriber set in which the error probability is reduced without significantly increasing the decision time, and which
95 is suitable for portable subscriber sets of the automatic personal telephone system. It is a further object of the invention to provide a subscriber set for signal transmission including user authorization means in which the error probability is reduced without significantly increasing the decision time.

100 The invention provides a method of determining whether a user is authorized to use a subscriber set for signal transmission and enabling the subscriber set if authorization is determined, said method comprising the steps of: comparing a representation of a first characteristic of the authorized user, which characteristic is stored within an authorization determining means, with a corresponding representation of the first characteristic entered by the user to the authorisation determining means; producing a first decision signal indicating
110 whether a sufficient correlation between the stored and entered representations of the first characteristic exists to imply that the user is the authorised user; comparing a representation of a second characteristic of the authorised user, which characteristic is stored within the authorisation determining means, with a corresponding representation of the second characteristic entered by the user into the authorisation determining means; producing a
120 second decision signal indicating whether a sufficient correlation between the stored and entered representations of the second characteristic exists to imply that the user is the authorised user; and enabling the subscriber
125 set if the first and/or second decision signals indicate correlation between the stored and entered representations of the user characteristic.

130 The invention further provides a subscriber set for signal transmission including user au-

thorisation determining means, said user authorisation determining means comprising means for storing a representation of a first characteristic of an authorised user; means for entering the first characteristic of a potential user and producing a corresponding representation thereof; means for comparing the stored and entered representations of the first characteristic and producing a first decision signal which indicates whether a sufficient correlation exists between the representations of the stored and entered first characteristics to imply that both were produced by the same person; means for storing a representation of a second characteristic of an authorised user; means for entering the second characteristic of the potential user and producing a corresponding representation thereof; means for comparing the stored and entered representations of the second characteristic and producing a second decision signal which indicates whether a sufficient correlation exists between the representation of the stored and entered second characteristics to imply that both were produced by the same person; means for applying the first and second decision signals to a subscriber set enabling means for producing an enabling signal when the first and/or second decision signals indicate correlation between the stored and entered characteristic(s).

As the second personal characteristic is independent of the first personal characteristic, the occurrence of incorrect decisions because of mutually dependent error causes is obviated. These mutually dependent error causes might, for example, be present if, to reduce the error probability, the other personal characteristic of the same type as the first personal characteristic, for example the voice characteristic, were chosen. In that case it is possible that because of, for example, the fact that the speaker has caught a cold or of permanent interfering background noise an incorrect decision as regards the user authorization of the speaker would continuously be taken.

With an embodiment of a method and a subscriber set which are suitable for simple and fast recognition the first personal characteristic may be formed by the voice characteristic and the second personal characteristic may be a finger of thumb print. Since using a subscriber set for signal transmission always implies that is touched by the user this touch can also be used for entering the finger print so that no additional manipulations of the user are required for this purpose.

An embodiment of the invention and its advantages will now be described, by way of example with reference to the accompanying drawing, in which the sole Figure shows by means of a block schematic diagram an arrangement of a subscriber set for signal transmission including user authorization determining means.

The arrangement shown in the Fig. 2 comprises four memories 1, 2, 3 and 4, a processing unit 5, two converters 6 and 7, supply means 8 and 9, an authorization circuit 10 and a mode selector 12. The arrangement is connected via the authorization circuit 10 to the further circuits of the subscriber set, shown schematically in the Figure by the set function circuit 11.

Memory 1 is a read-only memory, intended to store a representation of the voice characteristic of the authorized user. The term "read-only memory" must be understood to mean that the content of memory 1, and also the content of the read-only memory 3 still to be described, is not erased as part of the procedure for determining the user authorization. It is indeed possible that the read-only memories 1 and 3 are given a new content as part of a procedure for writing a characteristic of an authorized user into the memories. It is alternatively possible for the read-only memories 1 and 3 to be in the form of plug-in modules which are programmed outside the subscriber set.

The representation of the voice characteristic may assume different forms, as known from the prior art. For speaker recognition the representation of the voice characteristic may correspond to the representation for word identification, as described in the aforementioned IEEE-Article. The manner of storing a representation for word recognition is known *per se*, for example from the periodical "Mini-Micro Systems", June 1983, pages 242, 244 and 246, or from the periodical "Telecommunication Journal", Vol. 48, December 1981, pages 734 and 735.

Memory 2 is an erasable memory, intended to store a representation of the voice characteristic of a person wanting to use the subscriber set, called user hereinafter, which representation corresponds to that stored in the read-only memory 1.

Under the control of processing unit 5, prior to the use for communication purposes, the voice of the user is converted by converter 6 formed by a microphone 6-1 and an analogue-to-digital converter 6-2 into a representation of the voice characteristic, for example into a set of digital code words each representing a sample of the speech signal. The set of digital code words can be read directly into memory 2 under the control of processing unit 5 or can be processed first by processing unit 5 to form a different representation before being stored in memory 2. After the representation of the voice characteristic of the user has been stored in memory 2 it is compared to the representation of the voice characteristic of the authorized person. This manner of comparing is known *per se* and is described in, for example, said periodical "Mini-Micro Systems", page 244. If both voice representations show sufficient correla-

tion between each other, that is to say they are within a predetermined margin of each other, then the processing unit generates a first decision signal which indicates that the two representations are sufficiently similar to be assumed to emanate from the same person.

Speaker recognition on the basis of the voice characteristic has an error probability in the order of some percents. From said IEEE-article a value of 10% can be derived for the error probability (page 230, paragraph III-F). From the above-mentioned periodical "Mini-Micro Systems", pages 244 and 246 a value of 1% for the error probability for word recognition can be derived, but this value holds for optimum circumstances and may be considerably more in actual use. As for word recognition a method is followed which corresponds to the method of speaker recognition, it may be assumed that in both cases the error probability is of the same order of magnitude.

In order to reduce the number of times that the authorized user is not recognized as such, or that an unauthorized person is identified as authorized, as the case may be, the identity of the user is checked against a second individual characteristic which is independent of the first individual characteristic. In this embodiment the second characteristic is the fingerprint pattern.

In the read-only memory 3 a representation of the fingerprint pattern of the authorized user is stored. The manner of forming a representation of the pattern of a fingerprint is known *per se*, for example, from United States Patent No. 4,210,899 and from the article "Reducing Stored Requirements of Digitized Fingerprint Images", 1982 Carnahan Conference on Security Technology, University of Kentucky, 12-14 May 1982.

Memory 4 is an erasable memory intended to store the representation of the fingerprint pattern of the user. Entering the fingerprint pattern of the user into 4 the memory is effected in parallel with entering the voice characteristic of the user into the memory 2. To this end the subscriber set is provided in a suitable place with a window 7-1 on which the relevant finger is placed.

Window 7-1 forms part of a converter 7 for converting the fingerprint pattern into a representation suitable for storage and/or processing. In addition, converter 7 comprises a lighting element 7-4, for example a small incandescent lamp, a camera 7-2 and an analogue-to-digital converter 7-3. Camera 7-2 is a television pick-up element which is known *per se*, for example a CTD (Charge Transfer Device)—element. Such a television pick-up element is, for example, the Philips RGS-4 solid-state image sensor. In response to the pressure of the finger on the window 7-1 the lighting element 7-4 is switched on and camera 7-2 produces a signal representa-

tive of the fingerprint pattern. Under the control of processing unit 5 the camera signal is converted by analogue-to-digital converter 7-3 into a set of digital code words which is either directly stored in memory 4 or is first processed by processing unit 5 and then stored in memory 4.

After the representation of the fingerprint pattern of the user has been stored in memory 4 a comparison is made with the representation of the fingerprint pattern of the authorized user. The manner in which this comparison is effected is known *per se* from the prior art, such as, for example, said United States Patent Specification and from said article of the "Carnahan Conference". If these two representations show sufficient correlation between each other, that is they are within a predetermined margin of each other, then the processing unit generates a second decision signal which indicates that the two representations of the fingerprint patterns are sufficiently similar to be assumed to be produced by the same person.

With the first decision signal which relates to correlation of the voice characteristics, and the second decision signal which relates to the correlation of the fingerprints the subscriber set can now be enabled for communication. It is possible to enable the subscriber set if at least one of the decision signals indicates correlation; it is alternatively possible to only enable the set when both decision signals indicate correlation.

In the first case the probability of non-recognition of the authorized user is small, but it is possible that an unauthorized person may be erroneously identified as being authorized. In the second case the probability of non-authorized use is small, but the probability of non-recognition of an authorized user is increased. It is also possible to differentiate the enabling criteria on the basis of the intended use of the subscriber set. So it is, for example, possible that for expensive international connection both decision signals indicating correlation are required, whilst only one decision signal indicating correlation is required for the less expensive national connections.

Entering the personal characteristics of the authorized user can be effected outside the subscriber set. It is alternatively possible for the authorized person to enter his personal characteristics himself, after he has adjusted the subscriber set to a suitable state for that purpose, for example with the aid of a key, a magnetic identification card or with the aid of a numerical code which is entered via a number selection unit.

When the personal characteristics are entered by the authorized user himself, the subscriber set is adjusted with the aid of mode selector 12 in one of the above-described ways to the state suitable for storing the

personal characteristics of the authorized user. In this state the supply means 8 and 9 only transfer the information from the converters 6 and 7 to the memories 1 and 3, respectively.

- 5 After the personal characteristics of the authorized user have been stored, the subscriber set is readjusted to the normal mode of usage by removing the key or the identification card or by applying an appropriated numerical
10 code.

CLAIMS

1. A method of determining whether a user is authorized to use a subscriber set for
15 signal transmission and enabling the subscriber set if authorization is determined, said method comprising the steps of:

- comparing a representation of a first characteristic of the authorized user, which characteristic is stored within an authorization determining means, with a corresponding representation of the first characteristic entered by the user to the authorization determining means;
20 producing a first decision signal indicating whether a sufficient correlation between the stored and entered representations of the first characteristic exists to imply that the user is the authorized user;

- comparing a representation of a second characteristic of the authorized user, which characteristic is stored within the authorization determining means, with a corresponding representation of the second characteristic entered by the user into the authorization determining means;
30 producing a second decision signal indicating whether a sufficient correlation between the stored and entered representations of the second characteristic exists to imply that the user is the authorized user;

- and enabling the subscriber set if the first and/or second decision signals indicate correlation between the stored and entered representations of the user characteristic.
40 2. A method according to Claim 1 in which the first characteristic is a voice characteristic.

3. A method according to Claim 1 or 2, in which the second characteristic is a finger or thumb point.
50 4. A method of determining whether a user is authorized to use a subscriber set for signal transmission and enabling the subscriber set if authorization is determined, the method being substantially as described herein with reference to the accompanying drawing.

5. A subscriber set for signal transmission including user authorization determining means, said user authorization determining means comprising means for storing a representation of a first characteristic of an authorized user; means for entering the first characteristic of a potential user and producing a
55 corresponding representation thereof; means

for comparing the stored and entered representations of the first characteristic and producing a first decision signal which indicates whether a sufficient correlation exists between the representations of the stored and entered first characteristics to imply that both were produced by the same person, means for storing a representation of a second characteristic of an authorized user; means for entering the second characteristic of the potential user and producing a corresponding representation thereof; means for comparing the stored and entered representations of the second characteristic and producing a second decision signal which indicates whether a sufficient correlation exists between the representation of the stored and entered second characteristics to imply that both were produced by the same person; means for applying the first and second decision signals to a subscriber set enabling means for producing an enabling signal when the first and/or second decision signals indicate correlation between the stored and entered characteristic(s).

6. A subscriber set as claimed in Claim 5, in which the representations of the first and/or second characteristics of the authorized user are stored in one or more non-volatile memories which is/are programmed outside the subscriber set.
90 7. A subscriber set as claimed in Claim 5, in which the user authorization determining means comprises a first transducer for converting the first characteristic of the user into an electrical signal, a second transducer for converting the second characteristic of the user into an electrical signal, means for temporarily storing the electrical signals corresponding to the first and second characteristics of the user, and means for comparing the stored authorized user representations and the temporarily stored user representations.

8. A subscriber set as claimed in any of Claims 5, 6 or 7, comprising means for enabling the authorized user characteristics to be entered into one or more memories under the control of a switching arrangement actuated by the user.
100 9. A subscriber set as claimed in Claim 7, in which the switching arrangement is actuated under the control of a key.

10. A subscriber set for signal transmission substantially as described herein with reference to the accompanying drawing.
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